DTIC FILE COPY

AD-A225 130

Research Product 90-21

Conducting Precision Range and Integrated Maneuver Exercise (PRIME) After-Action Reviews

DTIC
ELECTE
AUG 0 8 1990
S B D

June 1990

PM TRADE Field Unit at Orlando, Florida
Training Research Laboratory

U.S. Army Research Institute for the Behavioral and Social Sciences

Approved for public release; distribution is unlimited.

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

Technical review by

Ronald E. Kraemer
Richard L. Peters (PM TRADE)

NOTICES

DISTRIBUTION: Primary distribution of this report has been made by ARI. Please address correspondence concerning distribution of reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, ATTN: PERI-POX, 5001 Eisenhower Ave., Alexandria, Virginia 22333-5600.

FINAL DISPOSITION: This report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS --
2a. SECURITY CLASSIFICATION AUTHORITY --	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE --	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ARI Research Product 90-21	5. MONITORING ORGANIZATION REPORT NUMBER(S) --
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Research Institute PM TRADE Field Unit 6b. OFFICE SYMBOL (If applicable) PERI-IF	7a. NAME OF MONITORING ORGANIZATION --
6c. ADDRESS (City, State, and ZIP Code) 12350 Research Parkway Orlando, FL 32826-3276	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences 8b. OFFICE SYMBOL (If applicable) PERI-I	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER --
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO.: 62785A PROJECT NO.: 790 TASK NO.: 3105 WORK UNIT ACCESSION NO.: H1

11. TITLE (Include Security Classification)
Conducting Precision Range and Integrated Maneuver Exercise (PRIME) After-Action Reviews

12. PERSONAL AUTHOR(S)
Witmer, Bob G. (ARI)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 88/10 TO 90/03	1990, June	

16. SUPPLEMENTARY NOTATION
--

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
PRIME; Tactical training; After-action review; Thru-sight video; Platoon gunnery; Performance measurement (Continued)

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The Precision Range and Integrated Maneuver Exercise (PRIME) is a prototype tactical gunnery and maneuver training system being developed by PM TRADE in conjunction with III Corps at Fort Hood. PRIME is designed to train armored vehicle crews and platoons in combat skills and measure their performance in a realistic setting. PRIME contains multimedia feedback systems that present detailed performance data to the unit. This report includes procedures for formatting and using the information provided by the feedback media and illustrates selectable data formats, each designed for a particular data reporting requirement. The report includes a firing events format, a marksmanship format, a vulnerability format, a weapon and target selection format, and two summary formats. The performance measurement capabilities of the basic Thru-Sight-Video (TSV) are discussed and a need for additional TSV recording and playback features is identified. The capabilities of a map graphics display medium are also discussed and desired capabilities are identified. Time constraints for organizing and presenting information during the after-action (Continued)

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Bob G. Witmer	22b. TELEPHONE (Include Area Code) (407) 380-4367 22c. OFFICE SYMBOL PERI-IF

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

ARI Research Product 90-21

18. SUBJECT TERMS (Continued)

Performance feedback
Training features

19. ABSTRACT (Continued)

review suggest that the PRIME feedback sources should be integrated for more efficient presentation of the data.

Accession For
NTIS GRA&I ☑
DTIC TAB ☐
Unannounced ☐
Justification
By
Distribution/
Availability Codes
Dist | Avail and/or Special
A-1

Research Product 90-21

Conducting Precision Range and Integrated Maneuver Exercise (PRIME) After-Action Reviews

Bob G. Witmer
U.S. Army Research Institute

PM TRADE Field Unit at Orlando, Florida
Stephen L. Goldberg, Chief

Training Research Laboratory
Jack H. Hiller, Director

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
Department of the Army

June 1990

Army Project Number
2Q162785A790

Human Performance Effectiveness and Simulation

Approved for public release, distribution is unlimited.

FOREWORD

The Precision Range Integrated Maneuver Exercise (PRIME) system is based on the "train as we will fight" training strategy. The primary purpose of PRIME is to train armor and mechanized infantry platoons in tactical gunnery and maneuver on their vehicles in a realistic setting. What sets PRIME apart from similar training systems is its automated data collection and feedback capabilities. PRIME provides detailed records of crew and platoon performance for purposes of training feedback during the After-Action Review (AAR).

This report contains information on how these performance records should be formatted and used to provide efficient and effective training of crews and platoons during the PRIME AAR. This work was performed by the PM TRADE Field Unit at the request of the Project Manager for Training Devices (PM TRADE), and has supported efforts by III Corps to upgrade the PRIME training system.

The development of formats and procedures for conducting PRIME AAR's is part of an ongoing effort at the PM TRADE Field Unit to enhance human performance effectiveness by obtaining maximum training value from simulation and training devices. The formats and procedures described in this document have been presented to personnel at PM TRADE and III Corps at Fort Hood. PM TRADE has recommended implementation of the fixed report computer formats to increase the training effectiveness and efficiency of PRIME. However, the procedures and conclusions in this report are those of the author and should not be interpreted as representing the position of III Corps or PM TRADE.

EDGAR M. JOHNSON
Technical Director

CONDUCTING PRECISION RANGE AND INTEGRATED MANEUVER EXERCISE (PRIME) AFTER-ACTION REVIEWS

CONTENTS

CONTENTS (Continued)

LIST OF TABLES

CONDUCTING PRECISION RANGE AND INTEGRATED MANEUVER EXERCISE (PRIME) AFTER-ACTION REVIEWS

Functional Description of PRIME

The Precision Range Integrated Maneuver Exercise (PRIME) is a training system for tactical gunnery and maneuver training for armor and mechanized infantry units. It is designed to train crews and platoons in combat skills and measure performance in a realistic setting. Distinguishing characteristics of PRIME include data recording and telemetry equipment appended to the vehicles and targets, semi-intelligent reactive targets that can fire back or be killed, and multi-media performance feedback systems. It combines the advantages of precision performance measurement, which is characteristic of stand-alone training devices, with the realism attending use of the weapon system to maneuver against and engage targets of opportunity. PRIME includes more than 50 possible target locations that can house thermalized pop-up targets with hostile fire simulators (i.e., Hoffman device). Hoffman devices are designed to produce the visual effects (flash and smoke) associated with being fired upon by a hostile vehicle. Designated targets are activated when a vehicle enters a predefined target presentation area and satisfies intervisibility requirements. Hence, crews cannot predict when or where a target will appear. Vehicles engage targets using an Instrumented Multiple Integrated Laser Engagement System (I-MILES) and targets fire back after a variable preprogrammed delay. I-MILES employs eye-safe lasers to simulate weapon firing and weapon effects using the actual equipment in a field setting. Vehicle and target identifiers and status (dead or alive) and position in Universal Traverse Mercator (UTM) coordinates are recorded by sensors and recording devices mounted on the vehicles and targets, and are transmitted via telemetry links to a centrally located range computer. The range computer processes the data and generates formats for use as crew or platoon performance summaries or as inputs to computer generated map displays. Thru-Sight Video (TSV) is appended to each vehicle for recording sight pictures and communications. Upon completion of the training, TSV tapes are manually retrieved from the vehicles and brought to the After-Action Review facility for viewing. As presently configured, PRIME requires dedicated personnel to program training scenarios and to assist unit leaders in developing and presenting After-Action Reviews. For additional detail regarding PRIME system equipment and capabilities, see Kraemer and Koger (1989), and U.S. Army, III Corps, G-3 Training (1988).

Effective platoon-level training using PRIME is a function of four activities: (1) design and implementation of training scenarios, (2) tactical planning and preparation, (3) mission execution, and (4) evaluation. The training scenario to include target characteristics and location, mission objectives and

conditions as described in the company operations order (OPORD), and placement of obstacles should be designed to meet unit training objectives. The OPORD contains essential information required to conduct the mission. Following scenario design, the scenario must be implemented through programming the PRIME range control computer. Implementation of the scenario will depend on the expertise and programming skills of PRIME personnel assigned to that task. Menus and help screens are currently under development to simplify the programming task. Tactical planning is a function of the mission, doctrine, and tactical planning and organizational skills of the platoon leader and his sergeants. Preparation to include preoperational checks and mission rehearsal is essential to effective mission execution. Execution of the mission is a function of the tactical gunnery and maneuver skills of the individual crews and the command and control skills of the platoon leaders. Support provided by range personnel in monitoring scenario events and in maintaining and repairing malfunctioning PRIME equipment is also crucial to mission execution. Evaluation is a function of the kinds of informational feedback available to those responsible for conducting the After-Action Review (AAR) and the manner in which the feedback is presented.

The information presented during evaluation is a function of unit training objectives, scenario characteristics, data recording capabilities, and planning and execution activities. This report provides guidance in evaluating individual and unit performance during PRIME scenarios using PRIME data sources and feedback systems. Emphasis is placed on how to conduct PRIME After-Action Reviews (AAR's) for platoon tactical gunnery and maneuver training. While much of the discussion is applicable to the current version of PRIME, recommendations for modifying the current system are made in order to encourage innovations that may improve the training effectiveness and efficiency of PRIME.

The AAR Process

The After-Action Review (AAR) was developed as a means to provide accurate feedback about the performances exhibited during tactical engagement simulation training exercises. The AAR examines the training exercise as a sequential chain of events in order to determine why specific actions are taken and how certain events influence subsequent outcomes (Scott, 1983). Other distinguishing characteristics of the AAR include active participation in the AAR process by all key players and thorough discussion of alternative courses of action. One effective way to encourage participation is to ask soldiers to explain why they performed a particular action and to describe other actions they might have taken (Downs, Johnson, and Fallesen, 1987). In the typical tactical engagement simulation exercise, most of the information used in the AAR is provided either by controllers or by opposing forces (OPFOR) personnel (Scott, 1983). Regardless

of its source, information feedback presented during the AAR should be factual, based on training goals and oriented towards behaviors, both good and bad (Downs et al., 1987).

The PRIME AAR

The integration of the PRIME system with I-MILES adds a new dimension to the collection of information for the AAR. PRIME permits automated collection of specific data for gunnery performance evaluation and exact position location information for firing vehicles and targets during tactical exercises. Information about firing vehicle and target status is sent from the vehicles and targets back to a centrally located range control computer that processes the information and generates selectable format reports of firing engagements and other scenario events. This information is supplemented by Through Sight Video (TSV) that shows reticle lay and tracking of targets, and records the audio for crew and platoon commands and communications. For some PRIME training applications, man-packed video cameras have been positioned to record the scenario from a target's perspective. This Target's Perspective Video (TPV) may be used to gather information about the employment of tactics to include the use of cover and concealment. Additional information is provided by a computer generated imagery (CGI) map display. This map display provides an graphic display of the vehicles in relation to targets and terrain features as the crews maneuver and fire. The use of PRIME permits the collection of a considerable amount of specific information without using controllers or observers to record the training events.

Tactical maneuver and gunnery skills are critical in determining the outcome of force-on-force engagements; hence, the capabilities of PRIME to provide precise feedback on tactical gunnery and maneuver may vastly improve combat effectiveness. The data provided by PRIME can be used to detect deficiencies in tactical gunnery and maneuver performance and identify the probable reasons for the substandard performance, such as failure to identify targets, use of the wrong weapon for a particular target, slow opening times, sloppy aiming techniques, or poor battle strategies and maneuver techniques.

Much of the data necessary for identifying the reasons for performance deficiencies can be recorded automatically by the PRIME system. This data may assist the crews and their instructors in identifying what went wrong and why. However, there is a danger that the soldiers will be overwhelmed by the massive data dump generated by PRIME and may not receive the full training value of the information provided. The data provided by PRIME is only advantageous to the extent that the data can be analyzed and organized in a manner that supports training.

Current approaches for conducting PRIME AAR's are deficient in that methods have not been developed for reviewing and presenting these data in a training effective and efficient manner. One objective of this report is the development of AAR data formats that organize and summarize the important feedback elements. Another objective is to provide strategies for using the various PRIME feedback sources in an integrated fashion during the AAR. A third objective is to provide suggestions for a future set of PRIME feedback capabilities that will further improve the PRIME AAR process.

The lack of a set of guidelines for integrating the various sources of feedback provided by the PRIME system is a major training system deficiency. Sources of feedback in PRIME include computer printouts, TSV tapes, and a map graphics display. Integrating feedback from these sources is required in order to conduct AAR's that are both effective and efficient. At the present time, the only integrating factor among the data sources is a common time code. This time code permits an instructor to identify an engagement or event for which the crew's performance is deficient on the computer printout and then locate the same event on the TSV tape or CGI map display to identify the reason for the poor performance. Additional steps must be taken to integrate the PRIME feedback sources. Better integration of the feedback sources will require additional hardware features and some additional software development. Hardware and software should be developed that allows quick access to designated scenario events and permits moving rapidly from one feedback source to the next.

The remainder of this report describes the feedback media that are available for conducting PRIME AAR's and details how these media may be used to conduct the AAR. Detailed discussions of feedback media describe the current capabilities of each feedback source followed by recommendations for improving feedback source capabilities to increase the efficiency and effectiveness of the AAR process. Existing PRIME feedback system capabilities along with those currently under development are then used to develop procedures for conducting PRIME AAR's. The procedures provide guidance for PRIME users in conducting PRIME AAR's. The final section outlines potential problems for conducting PRIME AAR's and proposes solutions to those problems.

AAR Feedback Elements

Table 1 presents an overview of the kinds of feedback that may be developed using the PRIME system. Feedback is divided into eight functional categories that consist of sets of related data elements or measures. The categories of feedback are: (1) planning and preparation; (2) tactical movement technique/survivability; (3) crew/platoon commands, reports, messages; (4) weapon selection and effective range; (5) target

acquisition/identification; (6) marksmanship; (7) ammunition conservation; and (8) distribution of fires. The data elements listed under each feedback element are the measures needed to provide feedback to unit leaders or crews about their performance.

Data elements within some categories are marked with symbols that indicate additional requirements that must be met in order to provide the data. Data elements with no designator symbol are measures that may be extracted directly from PRIME system recording devices and presented as feedback to the crews or platoon. The information in Table 1 suggests that PRIME as presently configured provides better data coverage for some feedback categories (e.g., marksmanship) than for others. Feedback categories for which many elements require additional hardware/software (e.g., tactical movement/survivability) and categories requiring data interpretation by an expert observer/evaluator (e.g., crew/platoon commands, reports, messages) suggest the need for better measurement methods. Table 1 also lists the source(s) of the data elements, or media where the data may be reviewed and suggests how the data might be packaged or formatted for presentation.

Table 1

AAR Feedback and Measures

Feedback Element: Planning and Preparation

Data Elements	Data Source	Presentation Format
+Doctrinal Conformity	Mission Plan Doctrinal Pubs	Paper maps with overlay Map Graphics Display
+Mission Preparation	Self Report	Oral Summary
+Consideration of Alternatives	Self Report Mission Plan	Paper maps with overlay CGI Map Graphics Display, Participative Discussion
**Flexibility	FRAGO's (TSV) Changes in Plans	TSV Segments, CGI Map Graphics Display

(table continues)

Feedback Element: Tactical Movement Technique/Survivability

Data Elements	Data Source	Presentation Format
*Vehicle speed (Distance/Time)	CPO & range map	Statement of time to reach the objective Speed ranking
$Use of Cover Use of Formations	CPO, TPV CGI map or TPV	Terrain board, TPV CGI map graphics display, TPV
Tracking of Planned Route	CPO & CGI map	Paper map with overlay or CGI map graphics display
Use of Overwatch	CGI, TSV or self report	CGI map graphics display
$Obstacle Avoidance	CPO & CGI map	Time by position plot using paper map with overlay or CGI map graphics display
No. of Kills by OPFOR	CPO	Summaries by scenario

Feedback Element: Crew/Platoon Commands, Reports, Messages

Data Elements	Data Source	Presentation Format
Timing & Freq of Communications	TSV	Oral summary & TSV segments
+Correct Commo Procedures Used	TSV	TSV segments of critical incidents
+Correct Fire Commands and Responses	TSV	TSV segments of critical incidents

Feedback Element: Weapon Selection and Effective Range

Data Elements	Data Source	Presentation Format
Weapon used for each Near Miss, Hit, Kill	CPO	Oral summary & examples of poor selection
Range of Targets by Weapon	CPO	Incidence of engaging targets beyond the effective range

(table continues)

Feedback Element: Target Acquisition/Identification

Data Elements	Data Source	Presentation Format
Firing Times with respect to Target Presentation	CPO	Oral summary across scenarios
**Crew commo (Gunner Time to Identify)	TSV audio & CPO	Oral summary or TSV segments
**Target Acquisition (Lay) Time	TSV & CPO	Oral summary or TSV segments
Target Prioritization	CPO, TSV	Oral summary & TSV
+Fratricide Count by Firing Vehicle	CPO, TSV	Oral summary or TSV segments

Feedback Element: Marksmanship

Data Elements	Data Source	Presentation Format
Hit Assessment by Firing Vehicle	CPO, TSV	Oral summary across scenarios
Tgt Range of Firing Events	CPO	Oral summary
**Reticle Lay/Tracking	TSV	TSV scenario segments
Firing Times with respect to Target Presentation	CPO	Oral summary across scenarios

Feedback Element: Ammunition Conservation

Data Elements	Data Source	Presentation Format
Rounds Fired per Targets Killed	CPO	Tabular presentation by vehicle
Rounds Remaining	CPO	Tabular presentation by vehicle

(table continues)

Feedback Element: Distribution of Fires

Data Elements	Data Source	Presentation Format
Sectors Assigned	Mission Plan	Paper range maps with overlays or CGI map graphics display
Identity & Location of Vehicles & Targets	CPO	Paper range maps with overlays or CGI map graphics display

Legend:
* Measure derived by combining or transforming other measures
** Precision measurement not available
$ Requires additional hardware or software development
+ Requires expert observer/evaluator
CPO PRIME Computer Printout
TSV Thru-Sight Video
CGI Computer Generated Imagery
TPV Target's Perspective Video

Except as noted by the "$" symbol, the feedback capabilities of PRIME listed in Table 1 are based on current PRIME system capabilities and approved modifications. The sources of this feedback are described below. The current capabilities of each feedback source are described followed by the specification of desired enhancements to the feedback source. The enhancements listed are those that in the opinion of the author are needed to improve data gathering and handling capabilities of each individual feedback source and to facilitate the AAR process.

Thru-Sight Video (TSV)

TSV is a means of recording the sight picture as seen by an armored vehicle crewmember through his sight optics. In the current TSV employed in PRIME, a beamsplitter is inserted into the sight optics that duplicates the sight picture for presentation to the video camera without interfering with normal use of the sight. The TSV systems now used in the M1 tank and Bradley Fighting Vehicle utilize a single video camera to record the scene simultaneously viewed by the gunner and vehicle commander. Current technology permits the simultaneous recording of both audio and video tracks on a single videotape medium. The events recorded by TSV are time tagged to aid in locating critical training events. TSV tapes can be used in tactical dry fire scenarios to record target acquisition parameters, laying or aiming the gun, scanning and tracking techniques, and visual or auditory communications. The ability of TSV to provide measures of tactical gunnery skills is a function of the features that are included in the TSV system and other measures that are collected

in conjunction with use of TSV. A pictorial representation of the visual information currently provided by the TSV is included as Appendix A. TSV is limited to the perspective of the crew as viewed through their sights and as heard in the crew compartment. TSV does not provide a panoramic or bird's-eye view of the battlefield nor does it show tactical movement patterns of the unit. Other recording media are needed for these purposes. The use of TSV in measuring target acquisition, gun laying proficiency, aiming skill, scanning techniques, tracking skills, and communication skills is described in the following paragraphs.

TSV is not a stand-alone training device; it is used in conjunction with a weapons system. However, it is not fully integrated with the system and must be installed whenever it is needed. In this respect it could be classified as a strap-on embedded training system. Classifying the TSV as an embedded training system in no way implies that it provides all the necessary training for the weapon system. In fact, TSV almost always complements other training systems such as PRIME and MILES.

TSV Current Measurement Capabilities

Target Acquisition. TSV can record some aspects of target acquisition, but requires additional data to describe performances in acquiring targets adequately. In behavioral terms, target acquisition requires target detection and target identification. In measuring detection, TSV will indicate the detection of a target by recording spot reports, fire commands, and the crew's zeroing in on the target. The first indication that a target has been detected will often be a fire command, gunner identification, or other crew vocalization, but rapidly slewing the gun tube to the target can also indicate target detection. The time that targets are detected can be read directly from the videotape by pausing the tape when detection is indicated and reading the time directly from the video monitor. The first indication of a target being detected should be used for determining target detection time. Time to detect, however, requires knowledge of when the target appeared or was presented. This information is not immediately available from the videotape unless the sight was pointing in the direction of the target when it first appeared. PRIME computers, however, may complement TSV by recording the time that each target is presented. Because of uncertainty in fixing the time of target detection and its dependence on interpreting crew vocalizations, this measure is frequently not exact. A failure to detect a target may be easier to ascertain than determining target detection time.

Target identification requires the crew to identify the vehicle by type (e.g., T72, BMP). Target identification is important for weapon and ammunition selection, target

prioritization, and avoidance of fratricide. Measurement of target identification requires realistically appearing targets whose true identity can be determined by an evaluator, and intelligible TSV audio of crew commands and reports.

Laying the Gun. The TSV can be used to evaluate the manner in which the Tank Commander (TC) or gunner lays the gun. The ability of the TC to slew the gun to the target and verbally direct the gunner onto the target as needed can be assessed using TSV. The critical measures are the distance in mils from the target that the TC lays the gun and the time elapsing between target detection by the TC and the time that the gunner announces "Identified" or otherwise indicates that he has identified the target. Evaluating gun lay requires that the video clearly show the reticle against a contrasting background. If the gunner, rather than the TC detects the target, the time between target detection and laying the gun on the target should be recorded.

Point of Aim at Time of Firing. Placement of the reticle on the target is critical to the measurement of the crew's gunnery skills. TSV can measure reticle placement to the extent that the reticle is clearly visible on the videotape and the time of firing is known. For dry fire applications, the TSV indicates that a round was fired by incrementing the rounds counter displayed in the lower left hand corner of the TSV picture. Other than crew reports, this is the only indication that a simulated round has been fired unless the target falls or shows other evidence of being hit. For live fire applications the TSV will record the sound of firing and smoke from the round. The smoke may temporarily obscure the picture recorded by the TSV. The distance in mils from the target center of visible mass can be determined by pausing the tape at the time of firing and then measuring from the point of aim to the target center of visible mass in azimuth and elevation. The mil lines on the reticle and the target must be clearly visible on the recorded video in order to reliably determine the point of aim.

Scanning Techniques. Problems in detecting targets may arise from poor scanning techniques. TSV provides a unique capability to record information regarding scanning techniques. Scanning techniques for lead or overwatch elements can be subjectively evaluated by a trained observer using the TSV tapes. TSV shows whether or not the gunner is scanning the terrain for targets, and the scanning speed when scanning occurs. It also shows whether the gunner is scanning the tops of the trees or the ground directly in front of his vehicle. It does not show whether the crew is observing its assigned sector. Evaluating scanning techniques with TSV requires a knowledgeable observer.

Tracking Skills. Tracking skills are among the most difficult skills to quantify. Precise measurement of tracking skill for the gunner or vehicle commander can be obtained using

TSV but not easily. Tracking can be measured by pausing the tape every second or two and recording the point of aim. Admittedly, this is a poor measure of tracking skill because pausing the tape exactly on cue may be difficult. Furthermore, it does not provide information on the smoothness of tracking performance. TSV allows a qualitative assessment of tracking behavior, but requires a knowledgeable observer to make an accurate assessment.

Ammunition Conservation. TSV maintains a record of each round fired, incrementing the round count each time the crew fires. This information may be used in conjunction with marksmanship data to evaluate the efficiency of the crew in neutralizing targets. It may also be used in conjunction with information about basic ammunition load to determine the number of rounds remaining at the conclusion of the scenario. TSV is not the best feedback source for ammunition conservation information because that information may be retrieved more quickly from the PRIME computer printouts.

Communication Skills. Communications measures are also difficult to quantify. Frequency, timing and duration of communications are quantifiable measures that can be obtained using TSV, but extraction and interpretation of these measures is a tedious and time consuming task. Hence, these precise communication measures are not practical for purposes of the AAR. The type and content of communications may also be obtained via TSV, given that the audio track is sufficiently intelligible. Visual communications such as arm and hand signals may also be recorded, given that the sights are pointed toward the communicator. Interpretation and evaluation of communication content requires a knowledgeable observer who is familiar with doctrine and the tactical situation. Such an observer would recognize inappropriate or incorrect communications and detect instances where communications would have been appropriate but did not occur.

Recommended TSV Capabilities

Cost to Benefit Ratio. Adding training capabilities to the basic TSV is going to involve additional costs. Training device developers should look closely at the costs of each proposed training feature. The following discussion assumes that the cost of providing a particular capability does not exceed its training benefit. Dollars spent on training features will provide their payback in increased training effectiveness and device utilization. However, with limited military budgets, some of the capabilities proposed in this report may not be included because of cost considerations.

Unique Target Identification. PRIME assigns a number that uniquely identifies each target and uses this target identifier to record changes in target status; TSV alone does not provide

the necessary information to distinguish similar appearing targets from each other, except as may be determined by a trained evaluator who might visually identify targets in known locations from terrain features in the target scene. Target identity (type and number) is needed to link target identifications and other events (e.g., target hits) to specific targets. Fire commands as recorded by TSV can be used to determine if the target was correctly recognized as a specific vehicle type (e.g., BMP, T72) by the crew, but additional information is needed to determine which T72 or BMP was correctly recognized. That is, TSV does not currently provide the means to reliably differentiate among several similarly appearing T72 target silhouettes. A means of uniquely identifying a target from the videotape alone would be valuable for evaluating target acquisition. Ideally a unique target identifier would be transmitted by each target for reception by the unit. An interface between the vehicle receiver and the TSV would cause the target identifier to be superimposed on the TSV recording of the target. This target identifier would not be visible to the crew during the training scenario, but would be superimposed on the video for after-action review purposes.

Observation of Assigned Sector. Determining a crew's observation of its assigned sector requires information about vehicle location and gun tube direction. Gun tube direction, in turn, requires vehicle heading information. Gun tube direction and vehicle location information could be superimposed on the video recording if available. PRIME provides vehicle location, but heading and gun tube direction may require additional vehicle instrumentation. The costs of providing heading and gun tube direction information may outweigh the benefit provided by this data if such information is used solely for the purpose of determining if the crew is scanning and engaging targets within its assigned sector.

Reticle Brightness/Contrast Playback Adjustment. It is essential that the reticle be clearly visible on the TSV recording. If the reticle brightness is not set to a level that is clearly visible or the contrast with the target and surrounding scene is not sufficient, aiming and tracking information may be lost. To prevent loss of data, some means of reticle enhancement for video recording or playback may be necessary.

Automatic or Remote TSV Activation and Shutoff. The number and kinds of measures obtained using TSV will depend on the training objectives and on the presence of other instrumentation for measuring tactical gunnery performance. Event sampling of video may be appropriate when the training objectives are limited to a few gunnery measures. Only those performance measures that will be reviewed and evaluated should be recorded. For example, if the primary training objectives involve target acquisition and

marksmanship, the video recording could begin when a target is presented and end when the target is killed or goes down. Of course other information such as measures of scanning or communicating may be missed, but if those skills are not being evaluated, then why record them? The recorded segments of the scenario would include only those parts of the total scenario that relate to the training objectives. The advantage of recording selected segments of the scenario is that unwanted and irrelevant information is excluded, making review and analysis of the data quicker and easier. For systems such as PRIME where target status and vehicular status information are routinely recorded, the technical problems of linking the initiation or cessation of video recording to target or vehicle status would appear to be minor. For example, TSV could be activated when a vehicle enters a target presentation area surrounding the target and shut off when either the target or vehicle is killed or the vehicle or platoon leaves the target presentation area. Video recording could also be initiated manually using PRIME to activate the recorder at critical junctures in the scenario or simultaneous with the initiation of a combat event to which the crew should respond (e.g., incoming artillery).

Automatic Search for Time or Vehicle Codes. For those cases for which event sampling is not appropriate, other techniques may be used to reduce the time required to present the critical events recorded on the videotape. One technique is to record the entire scenario, but only look at the key events in reviewing the tape. Presently, this involves manually fast forwarding the tape to a time-coded event. The fast forward control can be used in conjunction with the time code displayed on the videotape recording to locate an event. Alternately the fast forward can be used with the elapsed time display on the videotape machine to locate the event. The elapsed time display shows how much time has passed between the start of the tape and the event that may be currently displayed. While these features permit one to locate a particular event on the tape, the process is awkward and time consuming. Features could be added to the video playback system that permit the video player to automatically search for selected time, target or vehicle identification codes. The AAR presenter could key in the code for an event and the video machine would automatically search for that code and stop the tape at the appropriate point.

Overlay of Data on Videotape. TSV has the potential to increase the Army's ability to train and evaluate many aspects of tactical gunnery, but is deficient in that it provides only partial data for most measures of tactical gunnery performance. It requires additional instrumentation and/or modification to provide complete data. PRIME instrumentation complements TSV by providing much of the data that TSV cannot provide. But matching data on PRIME printouts with TSV records is a cumbersome procedure that could be simplified by overlaying some of the

information directly on the videotape. Information that should be overlaid includes true target identity and a salient firing indicator (e.g. flashing light or tone). Other possible candidates include vehicle location, vehicle heading, and gun tube direction. Care should be taken to ensure that the information overlaid on the videotape is easily seen, and does not clutter the tape to the extent that data extraction becomes difficult.

Intelligibility Requirements. The audio and video tracks of the TSV recording must meet minimum intelligibility requirements in order to provide any useful data. Reduction in intelligibility because of poor visibility conditions or poor audio quality will significantly diminish the training value of TSV. The audio recording system must be designed so that commands and reports are clearly audible, and features should be installed to monitor TSV audio to ensure intelligible audio recordings. Commanders should stress the importance of clear verbal communications and emphasize the importance of setting radio and headset controls to ensure quality recording.

TSV Training Features. The capability of TSV to be used in effectively training critical soldier skills will depend on the implementation of training features recommended in this report. Table 2 provides a partial list of training features and the types of training functions they serve or skills training they support. Some features support training of specific skills, while others assist the trainer in locating and presenting feedback on critical events.

CGI Map Graphics

CGI Map Graphics Capabilities

TSV does not provide an overall view of the events that occur during a training scenario and provides only limited information about vehicle movement and maneuver. Currently, PRIME is being modified to provide the capability to monitor the mission scenario using a CGI map graphics display. The map graphics display superimposes vehicle and target information on a high resolution color tactical map display of the range. The tactical map can include elevation lines, vegetation, and depressions as required by the user. The computer-generated video (CGI map display) provided by this display shows the position of vehicles in relation to known target locations at all times, and provides limited information about use of terrain by showing how the vehicles traverse the terrain toward the objective. It also provides information about target engagements, showing vehicle-target pairings and target engagement results. Bumper number enables easy identification of friendly vehicles and targets are labeled by type and number

(e.g., 16T72). Some of the symbology and features proposed for the graphics display are shown in Appendix B.

Table 2

Recommended Training Features for TSV

Training Feature	Function or Soldier/Crew Skill
Remote initiation/cessation of the TSV recording function	To reduce videotape length by recording only key events
Audio recording of crew communications	Fire commands, crew reports, detect and identify targets
Capability to receive external signals for display on videotape (e.g., target bumper no.)	Target identification
Distinctive audio/video firing to indicator	For use with I-MILES or other tactical engagement systems to pinpoint the exact firing time
Ability to enhance reticle brightness/contrast for video playback	Aiming
Pause/freeze frame	Aiming
Slow motion playback	Tracking moving targets
High speed playback	Provide quick overview or location of events for AAR
Automatic search for keyboard-entered time codes or vehicle/target ID codes	Quick access to specific scenario events for AAR
Playback synchronization of platoon tapes	Coordination of fires or use of overwatch techniques

Recommended Capabilities for CGI Map Graphics

Map Graphics as a Feedback Source. Computerized data communication and tracking networks (similar to PRIME) are currently being used to train tactical air combat maneuvering and weapons employment. One such system, TACTS, depicts real time computer-generated images of aircraft and their adversaries on a large video screen, shows aircraft altitude, velocity, and flight patterns, indicates weapons firings, shows missile flight trajectories, and indicates target misses and kills (Elias, 1988). A similar system, Air Combat Tactics Evaluation System (ACTES) has been demonstrated for air-to-air combat using F-16's. These airborne systems may serve as models for the development of similar systems for armored vehicles like the map graphics system being developed for PRIME.

Computer generated map displays have excellent potential for summarizing tactical maneuver and gunnery events and their outcomes in a single presentation medium for review by unit leaders. As the CGI map display media matures it may replace many of the data gathering and presentation functions now performed by TSV and PRIME computers. For example, CGI map display could be designed to record aiming and tracking data now recorded by TSV. Other measures provided by TSV (e.g., scanning) may not lend themselves to the CGI map display presentation.

Features for Measuring Tactical Gunnery and Maneuver. To display maneuver patterns, PRIME must track the path of each vehicle across the maneuver range. Vehicle location should be reported whenever there is a firing event. The location of other vehicles as well as the location of the target should be displayed when the vehicle engages the target or is engaged by the target. The display should differentiate between vehicle firing events and target firing events. Targets should not appear until they are activated and should show the effects of being hit or killed. Vehicles likewise should show the effects of target firings and change in appearance when reactivated to distinguish them from vehicles that were unscathed by enemy fire. Fast forward, rewind, and freeze frame capabilities are an absolute must in order to use the CGI map display in the After-Action Review.

The CGI map display should also provide information about intervisibility between vehicles and targets at the same rate as vehicle location information is reported. Targets should only appear on the map display when they have intervisibility with one or more vehicles. Vehicle icons should change colors when they are concealed and do not have intervisibility with any targets in the target presentation area. The CGI display should indicate a kill only when the intervisibility condition is satisfied. A vehicle emerging from a concealed position (i.e., intervisibility deadspace) should have a grace period of several seconds before a

vehicle-target pairing can occur. If one vehicle is visible and another is hidden, venicle-target firing events should only be displayed for the visible vehicle.

Another useful feature for the CGI map display would be an overlay that shows the planned platoon movement routes as described in the Operations Order (OPORD). This feature would allow platoon leaders to see how their OPORD influenced subsequent events and to evaluate crews on how well they followed the planned movement routes. A feature that permits the evaluation of fire distribution would also be useful. This feature would show each vehicle's sector of responsibility as defined in the OPORD, along with the line of fire, each time a vehicle engaged a target. The line of fire and the sector of responsibility should remain on the map display long enough (5 to 10 seconds) to detect the firing event and to pause the CGI map display to discuss the event.

Rapid Data Access Features. The CGI map graphics medium, like other real time data generation media, requires a means of extracting information relevant to training objectives and presenting the information in a manner that permits quick review and evaluation for after-action reviews. A means of stepping through the events recorded by this feedback source quickly and selectively would enhance its effectiveness as a training tool. This might involve skipping over entire sections of the output, or keying on selected events such as target presentations. If used in conjunction with the onset of key events, the CGI map display and the TSV recordings could be played back in synchrony in a dual or split screen arrangement. The crews could see how their tactical movement, scanning and marksmanship contributed to a successful or unsuccessful outcomes.

Data on tactical movement patterns are essential for training tactical gunnery, but these data are best presented in a condensed format that can be seen at a glance, as opposed to the video format that presents vehicle position in real time for the duration of the scenario. A single view of the scenario cannot capture the dynamics associated with vehicle movement and multiple firing events. A compromise solution would involve compressing the video recording in time, so that training events are speeded up in much the same way that time-lapse photography speeds up the growth of a plant. A compressed CGI map display format would allow unit leaders to review tactical movement patterns and other scenario events in a relatively short time period.

Map Display Features. The usefulness of the CGI map display in the AAR will vary in direct proportion to the features that it includes. A careful review of other map display systems (e.g., SIMNET plan view display) and other tactical engagement devices (e.g., TACTS) should guide the development of the PRIME CGI map

display. The design of features that appear on the map as well as flexibility in determining which features appear for different training purposes will be critical to using the CGI map display in the AAR. For example, using icon color to indicate the use of cover and concealment provides feedback to crews about their use of terrain. Flexibility to vary the design of the map format prior to the executing the training scenario is critical. Features such as contours, grid lines, alternate map scales, vehicle heading, vehicle speed, gun tube direction, and numerical representation of UTM coordinates may or may not be needed, depending on the training application and training objectives. Minimally the CGI map display should show vehicles, targets, key terrain features such as hazards or obstacles, time tags, and vehicle-target pairings for all firing events. The identity and location of targets and vehicles should also be shown. Different icons should be used to represent different vehicle and target types, and the icons should change as a function of intervisibility and vehicle or target status.

Other Potential AAR Media: Magnetic Range Maps, Terrain Boards, and Sand Tables

Dynamic graphic representations and pictorial diagrams may be useful for recreating the action that occurred during the scenario. A magnetic board divided into UTM grids with targets and vehicles that can be positioned and repositioned could be used for displaying targets and the relative position of the vehicles when the rounds were fired. Terrain boards or sand tables representing the PRIME range terrain could be used to demonstrate tactical maneuver and use of cover and concealment. These presentation media may also be useful when discussing alternate courses of action, or when evaluating the use of firing sectors.

PRIME Computer Printouts

Current Printout Format Deficiencies

The formats originally designed for PRIME are not adequate for purposes of the After-Action Review (See Appendix C for examples). Their primary drawback is that they do not present the important information in a form that allows easy data extraction and feedback. The sheer number of events presented in these formats is intimidating and the events are not organized functionally to allow focusing on the events of immediate interest. The ARI Field Unit in Orlando, in coordination with PM-TRADE, has developed alternatives to these formats. The resulting formats are described below. Work is currently underway at PM-TRADE to implement these alternative formats.

Design and Use of PRIME Computer Printouts

PRIME Computer Printouts as a Feedback Source. The PRIME printout is an important source of data for conducting the After-Action Review (AAR). The term computer printout as used in this report refers either to a hardcopy paper printout or to a printout of results on a video screen. The primary function of the printout is to provide detailed information about events occurring during the training scenario. Depending on how the information is formatted, the printouts can be used by platoon leaders to obtain a summary of their platoon's performance for identifying training deficiencies or by crews to determine the reasons for their success or failure in engaging targets. In addition, information on the PRIME printouts may be used to locate events in time on the TSV tapes or on the computer-generated map display. The categories of information that must minimally be included on the computer printouts are listed and defined in Table 3. These categories are used in designing formats that serve particular training purposes. The data within each category may be summarized to provide additional information. The effectiveness of the feedback provided by PRIME computer printouts is determined by the organization and summarization of data for specific feedback purposes.

Table 3

Computer Printout Information Categories

Information Category	Definition
Time Tag	The point in time that the event or effect occurred
Firer	The identity of the vehicle or target that simulates weapon firing
Veh #	A bumper number that uniquely identifies each crew undergoing training
Tgt #	A number that uniquely identifies each target. Targets presented at the same time should be labeled to indicate multiple target presentation (e.g., Tgt 7a, 7b, 7c)
T Type	The type of target (e.g., T72, BMP) engaged
Range	The range (in meters) from the firer to the vehicle or target receiving the fire

(table continues)

Information Category	Definition
Ammo	The type of ammunition used by the vehicle in engaging the target
Rnds	The number of rounds fired for a single event
T Event	An event that affects a target
V Event	An event that affects a vehicle
F Time	The time (in seconds) elapsing between presentation of a target and when it is fired on
FB Time	The time (in seconds) elapsing between presentation of a target and when it fires back at a vehicle
V Status	The condition of a vehicle as the result of an event
T Status	The condition of a target as the result of an event
Tgts Not Engaged	The target number identifier of targets that did not receive platoon direct fires
Miss	A round fired that registers no effect on any target
N Miss	A round that comes close enough to a target to register a near miss
Hit	A round that hits an alive target but does not kill it. A target that has been hit can still return fire
Kill	A round that neutralizes the target so that it no longer is a threat. A target that has been killed may remain "Up" but cannot return fire
% Tgts Hit/ Killed	The percentage of targets presented during an engagement that were hit or killed

Exemplar Formats. The following formats are suggested for presenting performance measures to the vehicle crews. Minimally the crews should be able to access each of the formats listed below via a menu. Additional formats may be needed depending on unit training objectives. The capability to print the formats or

call up a format for display on the video monitor should be available at the After-Action Review facility. Data Base III commands such as SORT, INDEX, DISPLAY, and FIND can be used to locate and organize data in different formats. Other Data Base III commands (e.g, COUNT FOR) can be used to calculate the summary measures. The capabilities of Data Base III to compile summary measures was an important consideration in organizing the performance data into different formats and in structuring each format. Five measures, Range, Fire Time, Fire Back Time, Targets Not Engaged, and Percent Targets Hit/Killed must be computed from other measures. Target Range is derived from the UTM coordinates of the vehicle and target, while Fire Time and Fire Back Time are calculated from target presentation time and time of firing. Targets Not Engaged is derived by comparing the targets receiving platoon fire during an engagement with the list targets presented. Percent Targets Hit/Killed is calculated by dividing the number of targets presented during an engagement by the number of targets that were hit or killed. These measures should be calculated by Data Base III and included in the AAR formats.

Displaying Computer Printouts. Displaying AAR formats on a video monitor has some advantages over using paper printouts, particularly if the capability exists to call up formats and scroll through their contents. Time is saved by not having to print records for each crew, the platoon leader, and the AAR facilitator before conducting the AAR. The amount of paper generated by a single platoon is considerable, and when multiplied for a company or battalion size unit, the volume of paper becomes enormous. Presenting the performance data on the monitor using the formats listed in Tables 4-9 allows the participants to view a coherent block of information in a form that allows data items to be located quickly. These items can then be used as points of discussion for the AAR or as indices for locating additional information on the TSV or CGI map display records. The capability of directly accessing the TSV or CGI map display records from the video monitor would be very useful. During the AAR, data would be retrieved in a selected AAR format and displayed on the monitor. Pointing to or highlighting a row of data and pressing ENTER would cause the corresponding TSV recording to appear on the monitor via the time tag that is common to all formats. Pressing ENTER a second time would cause the corresponding CGI map display record to appear and pressing ENTER a third time would return to the original printed format. The computer would search the TSV tape or CGI map display records to find the appropriate time tag and begin playback at that point. With a dual or split screen arrangement the TSV and CGI map display recording could be viewed simultaneously.

Formats that can be used in conducting After-Action Reviews are described below. The four basic formats are: (1) the marksmanship format; (2) the vehicle vulnerability format; (3) the firing events format; (4) the weapons and target selection

format. These formats are named according to the type of feedback that they provide. In addition, two summary formats, the Platoon Marksmanship Grand Summary and the Platoon Marksmanship Engagement Summary, are described. The summary formats are designed primarily for use by unit leaders to examine platoon performance. Each format description is accompanied by sample data that illustrates the format. The sample data for each format were chosen to illustrate the kinds of information that are provided by that particular format. Hence, these data are not necessarily consistent from one format to the next.

Marksmanship Format. The marksmanship format (see Table 4) captures information about the speed and accuracy of gunnery performance and displays this information for each firing event. It can be used in conjunction with the Weapon and Target Selection Format and the TSV recording to pinpoint the reasons for good or poor gunnery performance. Marksmanship information can be organized in at least two ways, by firing vehicle and by target being engaged. Whether organized by target or by firing vehicle, the information should be presented in chronological order for each vehicle or target. The "By Vehicle" organization would be the obvious choice for use with TSV because the listing by vehicle parallels the individual videotape presentation for each vehicle. The "By Target" organization is also useful because it shows each crew how the platoon collectively engaged each target. For either organization, the platoon leader needs summary data for speed and accuracy measures. The average fire time, as well as the number of hits, near misses, and kills should be printed for each scenario. Misses are not listed in the target events category because the targets only sense rounds that strike the I-MILES sensors; therefore no effect is shown for cases where a crew misses the target by a wide margin. In addition, the average fire time and number of kills should be printed for each vehicle in the "By Vehicle" listing. The number of targets presented, including those that were not engaged, is also listed in the summary. In the example below, Target 10 was presented but was not fired upon by any vehicle in the platoon. Because the marksmanship format presents only vehicle firing events, Target 10 does not appear in the listing of target events but it is counted for purposes of the summary.

Table 4

Marksmanship Format

Time Tag D HH MM SS	Firer	Tgt #	Range	T Event	F Time
3 12 49 28	Gold 4	Tgt 6	1200	Hit	12.5
3 12 51 30	Gold 4	Tgt 8	1530	N Miss	8.2
3 12 51 44	Gold 4	Tgt 8	1500	Kill	22.2
3 12 55 32	Gold 2	Tgt 7	1640	Kill	9.1
3 13 20 24	Gold 2	Tgt 12	1700	----	12.4
3 13 25 10	Gold 3	Tgt 13	900	----	13.6

Summary: Targets Presented 6, No Effect 2, Near Misses 1, Hits 1, Kills 2, Mean Fire Time 13.0
By Vehicle Summary: Gold 4: Kills 1, Mean Fire Time 14.3
Gold 2: Kills 1, Mean Fire Time 10.8
Gold 3: Kills 0, Mean Fire Time 13.6

Vulnerability Format. The vulnerability format presented in Table 5 provides information about a crew's or platoon's ability to detect targets quickly and to use terrain and fire power to avoid being killed. The vulnerability format is not a "vulnerability table" showing which targets are vulnerable to a particular ammunition or weapon. Rather, it shows which targets killed each vehicle, the elapsed time between presentation of the target and target fireback, and the range from which the vehicle was engaged. It also shows when "dead" vehicles are "resurrected" for further training. Vulnerability information is best organized "By Vehicle" so that it can be used with TSV to show crews what they were doing when they got killed. Events for each vehicle should be arranged in chronological order.

Table 5

Vehicle Vulnerability Format

Time Tag D HH MM SS	Firer	Veh #	Range	V Event	V Status	FB Time
3 12 52 01	Tgt 7	Gold 4	1620	N Miss	Alive	30
3 12 52 31	Tgt 7	Gold 4	1600	Kill	Dead	35
3 13 00 00	-----	Gold 4	----	Resurrect	Alive	-----
3 13 12 23	Tgt 10	Gold 2	1350	Kill	Dead	35
3 13 19 20	------	Gold 2	----	Resurrect	Alive	-----

Summary: Vehicles Missed 1, Vehicles Killed 2, Resurrections 2
Mean Fire Back Time 33.3

Firing Events Format. In order to get a more comprehensive picture of the firing events for both friendly vehicles and enemy targets, a firing events format can be used. The firing events format presented in Table 6 is a hybrid cross between the marksmanship and vehicle vulnerability formats. The advantage of this format is that it shows the interactive firing between vehicles and targets in chronological order. An important feature of this format is that firing events affecting vehicles are clearly distinguished from those affecting targets, and all other events (e.g., target presentations, vehicle resurrections) are excluded. This format organizes information chronologically, but the information could also be organized by vehicle, with events for each vehicle sequenced chronologically.

Table 6

Firing Events Format

Time Tag D HH MM SS	Firer	V Event/ T Event	Range	Veh #/ Tgt #	F Time	FB Time
3 12 49 28	Gold 4	T Hit	1200	Tgt 6	12.5	----
3 12 51 30	Gold 4	T N Miss	1530	Tgt 8	8.2	----
3 12 51 44	Gold 4	T Kill	1500	Tgt 8	22.2	----
3 12 52 01	Tgt 7	V N Miss	1620	Gold 4	-----	30
3 12 52 31	Tgt 7	V Kill	1600	Gold 4	-----	35
3 12 55 32	Gold 2	T Kill	1640	Tgt 7	9.1	----
3 13 12 23	Tgt 10	V Kill	1350	Gold 2	-----	30
3 13 20 24	Gold 2	------	1700	Tgt 12	12.4	----
3 13 25 10	Gold 3	------	900	Tgt 13	13.6	----

T Summary: Targets Presented 6, No Effect 2, Near Misses 1, Hits 1, Kills 2, Mean Fire Time 13.0
V Summary: Vehicles Missed 1, Vehicles Killed 2
By Vehicle Summary: Gold 4: Kills 1, Mean Fire Time 14.3
Gold 2: Kills 1, Mean Fire Time 10.8
Gold 3: Kills 0, Mean Fire Time 13.6
Loss Exchange Ratio (Targets Killed/Vehicles Killed): 1.0

Weapon & Target Selection Format. The function of this format, displayed in Table 7, is to provide crews feedback on their weapon selection for particular types of targets. It also shows the status of the target just before the firing event occurred, so that crews can determine if they are wasting rounds on targets that have already been killed. Weapon selection information, used in conjunction with target type and target range is valuable for identifying instances where the weapon selected was inappropriate for the target or where the weapon was fired at a target beyond its effective range. For example, the COAX machine gun is effective out to 900 meters, and use of the COAX to engage the HIND Helicopter at 1520 meters resulted in a

target miss. A "By Vehicle" organization of the data is recommended, with events for each vehicle listed in chronological order.

This format may also be used to determine the efficiency of ammunition use in killing targets. For each firing event the number of rounds and effect of the rounds on the target are printed. All firing events are listed, including those in which the round completely misses the target. In the exemplar format below, target 12 was not affected because it had already been killed, and the round fired at target 13 did not come close enough to register a Near Miss. The summary lists the number of rounds fired for each weapon type and a measure of killing efficiency in terms of rounds used per target killed.

Table 7

Weapon and Target Selection Format

Time D HH MM SS	Tag	Firer	T Status	Tgt #	T Type	Range	Wpn	Rnds	T Event
3 12 49 27	Gold 4	Alive	Tgt 6	T72	1200	MAIN	1	Hit
3 12 51 26	Gold 4	Alive	Tgt 8	Hind	1520	COAX	1	N Miss
3 12 51 50	Gold 4	Alive	Tgt 8	Hind	1500	MAIN	1	Kill
3 12 55 31	Gold 2	Alive	Tgt 7	BMP	1640	MAIN	1	Kill
3 13 20 24	Gold 2	Dead	Tgt 12	BMP	1700	MAIN	1	----
3 13 25 10	Gold 3	Alive	Tgt 13	T72	900	MAIN	1	----

Tgt & Weapon Selection Summary: Number of dead targets engaged 1
Targets engaged beyond effective range of weapon 1
Ammo Summary: MAIN 5, COAX 1 RNDS/TGT KILL 6/2
Ammo Summary (By Vehicle): Gold 4, RNDS/TGT KILL 3/1
Gold 2, RNDS/TGT KILL 2/1
Gold 3, RNDS/TGT KILL 1/0

Platoon Marksmanship Grand Summary. For purposes of a quick overview of the marksmanship exhibited by the crews in the platoon, some units may desire a breakdown of engagement outcomes by crew as shown in Table 8. The platoon leader might use this to distinguish "killer crews" from crews that fired but missed and from those that did not fire. Caution is advised in using the grand summary data in this manner because some crews may have had more opportunities to engage targets than others due to vehicle position at the time of target presentation or other factors. A particularly fast crew may engage most of the targets before others in the platoon are able to fire a round. This may mask the ability of slower crews to effectively neutralize targets. Emphasis on "killer crews" may foster an atmosphere of competitiveness that is counterproductive to effective platoon team operations. The purpose of the AAR is to provide feedback

that leads to improved platoon performance. Using the grand summary to draw conclusions about the performances of individual crews without analyzing the actions and behaviors that led to those performances is a poor training technique.

The grand summary may provide useful information to the platoon leader or AAR facilitator. It shows the number of rounds fired relative to the number of misses, near misses, hits, and kills. For summary purposes, all rounds that were fired but had no effect on any target are listed as misses. It also lists the targets presented and indicates which targets were killed. This data may assist the AAR facilitator in selecting target engagements for review during the AAR. A particularly good performance by one or more crews in engaging a set of linked (multiple) targets could be identified quickly from this format and looked at more closely with TSV or CGI map display recordings. Targets that were presented but not killed suggest poor platoon performance and may be used to identify engagements on which the platoon performed poorly.

Table 8

Platoon Marksmanship Grand Summary

Firer	Rnds	Misses	Near Misses	Hits	Kills	Tgts Killed
Gold 1	0	0	0	0	0	NA
Gold 2	2	1	0	0	1	#7
Gold 3	1	1	0	0	0	NA
Gold 4	3	0	1	1	1	#8
Summary:	6	2	1	1	2	#7,#8

Targets Presented: #6, #7, #8, #10, #12, #13

Platoon Marksmanship Engagement Summary. PRIME allows targets to be linked so that they are presented simultaneously. Targets that are presented in close proximity to one another in space and time may be considered as constituting a single engagement. When targets are presented in this manner, the platoon marksmanship engagement summary may provide a quick, concise overview of the platoon's performance. This format is adapted from a platoon battle drill engagement format developed at Ft. Hood. The battle drill engagement format presents detailed information for each individual engagement on a single printout page (See Appendix D). The platoon marksmanship format collects the data from individual engagements to allow a concise presentation of the set of engagements constituting the scenario.

The primary purpose of this format is to permit quick examination of the platoon's marksmanship performance to aid in selecting good or poor engagements for detailed review.

Engagements are defined by an engagement start time and by identifying the targets presented. Targets that did not receive any direct fire are listed to allow identification of engagements for which the platoon did not acquire the targets presented. The CGI map display may be used to verify that a particular target was not engaged. The percentage of targets that received hits or kills provides a gross measure of accuracy and may be used in selecting engagements for closer examination of platoon marksmanship. The number of rounds fired for each engagement can be compared to the targets presented to determine if ammunition is being conserved or wasted. The average fire time measure gives a gross measure of the platoon's speed in acquiring and engaging targets. Slow fire times may indicate a problem that can be analyzed by reviewing TSV tapes.

Table 9

Platoon Marksmanship Engagement Summary

Engagement Start Time D HH MM SS	Tgts Presented	Tgts Not Engaged	Rnds	% Tgts Hit/Killed	Mean Fire Time
3 12 49 15	#6	-----	1	100	12.5
3 12 51 22	#7,#8	-----	3	100	13.2
3 13 20 12	#10,#12,#13	#10	2	0	13.0
Summary:	6	1	6	66.7	12.9

Target's Perspective Video (TPV)

TPV Capabilities

The primary purpose of this feedback source would be to evaluate tactical movement from the perspective of potential targets. For example, a video of a platoon's tactical movement towards an objective could be used to evaluate the platoon's use of cover and concealment. Such information could be used by the company commander in providing feedback to platoon leaders about their tactical movement. Currently, PRIME does not include a TPV capability. However TEXCOM has used this capability in conjunction with PRIME to provide information on tactical movement through the use of portable man-packed video cameras positioned at strategic locations downrange. During a customer test of PRIME, cameras were placed on a hill near a defile and in the woods near a battle position. During the test, problems were experienced with the quality of the TPV recordings due to too much scanning, zooming in and out, and camera unsteadiness (Kraemer and Koger, 1989).

Suggested TPV Capabilities

TPV recordings could be improved by mounting the cameras on portable tripods and providing more operator training (Kraemer and Koger, 1989). An alternate, though more expensive, solution would to develop TPV cameras that scan 360 degrees around strategic positions and automatically lock on approaching vehicles as they are detected. When the vehicles are no longer visible to the camera, scanning would resume. TPV's should be positioned to cover different areas of the training range. The number of TPV cameras used during a training scenario must be limited because of the time required to review each TPV tape.

The desirability of using TPV for AAR purposes is questionable, particularly when the emphasis is on gunnery. The time required to review this additional data source may be prohibitive, and the functions it serves could be provided by adding capabilities to the CGI map display. However, if the primary emphasis of the training is on the development of maneuver skills, the TPV data may be an important data source. In the latter case the TPV may be used instead of the TSV.

Procedures for Conducting PRIME AAR's

Structuring the AAR

The After-Action Review (AAR) for PRIME platoon runs should be conducted in three separate phases. The level at which the information is presented and the presenters and recipients of the information will change across the three phases. The manner in which the various PRIME feedback media are used will also vary across the three phases. In phase 1, the Company Commander or his executive officer with the assistance of the PRIME AAR expert will provide an overview of scenario events and mission outcome to the platoon leader and the platoon sergeant. In phase 2, the platoon leader, assisted by the AAR expert, will summarize the scenario conditions and scenario outcomes for his crews and select events for phase 3 presentation. The events selected for phase 3 should teach important lessons as expressed in the training objectives. The purpose of phase 3 is to provide specific feedback to the crews about performance during selected events. The platoon leader assisted by the AAR expert conducts phase 3. Recommendations for conducting each phase of the AAR are provided in the following paragraphs.

Each phase requires the assistance of an AAR expert. The AAR expert is needed to help the unit derive maximum training benefit from the information that PRIME provides. The AAR expert must be familiar with the features and capabilities of PRIME to include PRIME scenarios, operation of equipment, performance evaluation methods, and the AAR formats available through each feedback medium. The expert must also be aware of unit training objectives and immediate training goals.

Phase 1: Review Scenario Outcomes with Platoon Leader

Phase 1 should begin with the company commander's brief statement of the training objectives. The commander should then describe the tactical situation and review the company OPORD that was issued. The platoon leader should briefly describe the OPORD that he issued to his platoon and discuss possible alternatives with the Company Commander. The Commander assisted by the AAR expert then provides the platoon leader and platoon sergeant with an overview of the outcomes of the training scenario. Outcome measures discussed must relate to the training objectives. Summary measures from the various computer printout formats and the platoon marksmanship summaries may be used to provide outcome measures for gunnery. The computer-generated imagery map display can be used to assess overall maneuver performance and adherence to the OPORD. The CGI map display should incorporate features that allow review of the training scenario in real time and in a high speed play or still frame snap shot mode for efficient review of platoon performance. Fast forward and freeze frame capabilities should also be included. Reasons for favorable or unfavorable outcomes should be identified including unit strengths and weaknesses that directly contributed to those outcomes. Alternate courses of action that the unit might have taken should be discussed. The platoon leader should take notes during this phase for subsequent review and for use in briefing his platoon during phases 2 and 3. The platoon leader should note the time of occurrence of critical events (e.g., poor maneuver techniques that result in unit casualties) so that these events can be located quickly during phase 3. The AAR expert should also take notes, recording the time of critical events.

Phase 2: Brief Crews on Platoon Performance

During Phase 2, the platoon leader should describe the tactical situation, and review his OPORD and plan of action for his crews. He should also present a summary of the outcome of the training scenario, concentrating on platoon performance and presenting summary measures for individual crew performances as needed. The AAR expert may assist the platoon leader in presenting this summary. The summary measures presented during this phase will come primarily from the computer printout summaries, but also from information obtained by the platoon leader from the CGI map display or company commander during Phase 1. By vehicle summaries provide information about the gunnery performance of individual crews and the platoon marksmanship summaries provide a quick reference for determining which of the targets presented were hit or killed and which were not. The platoon marksmanship engagement summary may be used to identify strengths and weaknesses in target acquisition, and speed and accuracy of gunnery performance. The platoon leader may use these data for identifying the vehicles, targets, and engagements

associated with favorable and unfavorable outcomes. This information is then used to identify specific events for closer examination.

The platoon leader uses the various AAR computer printout event listings in making his selections and for determining the time tag associated with each firing event. Maneuver events selected for training (during Phase 1) should also be identified at this time. Three or four events should be selected for closer examination, with two or more events representing unfavorable outcomes and at least one event representing a favorable outcome. Showing crews an unfavorable outcome for an event followed by a favorable outcome for a similar event has been shown to be an effective presentation technique in some cases (LTC R. Peters, personal communication, May 5, 1989). The selection of events for training purposes may occur at any time prior to phase 3, including during the conduct of the training scenario.

Phase 3: Examine Critical Training Events

Phase 3 begins following the selection of three or four events for training. The events are selected and presented by the platoon leader with the assistance of the AAR expert. Each of the events will be examined more closely by looking at the event in different formats and on different media. For gunnery, examining the various formats may reveal not only what happened, but also why it happened. Soldiers' comments may also be a source of information for explaining the reasons for success or failure. If the reasons for the performance observed are not clear, gunnery performances can be examined more closely by reviewing the relevant segments of the TSV tapes. TSV is ideal for identifying deficiencies in aiming and tracking skills, but can measure other gunnery skills as well. The CGI map graphics display may also be used to examine gunnery performance, especially when collective gunnery skills and team performance are being emphasized. For example, use of overwatch, selection of firing positions and distribution of fire are best evaluated using the CGI map display media. The time tag on the computer printouts may be used to locate firing events on the TSV tape or on the CGI map display.

Maneuver skills can be evaluated using the CGI map display, but locating maneuver events to be used as training feedback may prove difficult. One technique is for the platoon leader to note the time of occurrence of critical maneuver events during Phase 1, and use these times to locate CGI map display segments for Phase 3. Another technique is to use firing events as markers to indicate target presentation and back up the CGI map display recording several seconds to determine how effectively the vehicles were using maneuver just prior to target presentation. Firing events separated in time can be used as markers to determine how the platoon used formations and cover and

concealment in moving between firing points. Events known to have occurred between two engagements such as encountering and bypassing an obstacle or responding to a warning order or report can be located in this manner. If the time that an event occurs is predetermined (e.g., a simulated NBC attack), this time can be used directly to locate the platoon's response to the event.

PRIME AAR Problems and Potential Solutions

Time Constraints

Training time is limited, and to achieve maximum efficiency in utilizing PRIME ranges, units must run through the scenarios in quick succession. This allows limited time for crew or platoon runs, and consequently the time for developing and presenting the AAR is limited. During a recent customer test of PRIME, the platoon runs averaged about one hour per run. The time to develop and present the AAR probably should not exceed the time for a platoon run (i.e., one hour). While an hour seems like plenty of time for the AAR, the volume of data available with PRIME, and the requirement to integrate various data sources may limit the information that can be assembled and presented in this time period.

Integration of PRIME Feedback Sources

The volume of data available for use as feedback during the AAR suggests lengthy AAR's unless time saving steps are implemented. The implementation of the fixed report AAR formats shown in Tables 4 -9 should help reduce the time required to conduct AAR's as should the inclusion of additional TSV and CGI map display training features. But the real time savings will come with the integration of the various feedback sources. Currently PRIME feedback sources are not well integrated; consequently, switching from one feedback media to the next during the AAR may be awkward and time consuming. Integrating the PRIME feedback systems, so that the AAR presenter can rapidly access the same events from the computer printouts, TSV or CGI map display is the key to saving time during the AAR. Split screen or windowing arrangements might also be used to present feedback from different feedback sources simultaneously. Currently PRIME feedback systems are not integrated to a degree that would allow these capabilities.

Data Selection for Feedback

Another time saving strategy is to present feedback only for those events that the soldiers need to improve their performance and otherwise would not have known without the AAR feedback. For example, if the soldiers can determine during the scenario that they killed a target, then it is unnecessary to repeat this information during the AAR. On the other hand, if they were

killed by a target 30 seconds after it was presented because they were not properly scanning their sector, then such information needs to be presented in the AAR to allow the crew to take corrective action. Summary data that describes performance measures that sum up the performance of the crew or unit in terms of their speed, accuracy, or ammunition use also should be included in the AAR because they help soldiers see how their performance compares to a standard or to their performances during a previous scenario run.

Platoon Training and Feedback

A crew does not have to be directly involved in an action to learn from it. That is, one crew may learn from another crew's successes or mistakes as long as the context under which the action occurred is known and the action and its outcome is described in sufficient detail. The facilitator will not have time to discuss every engagement for every crew. Instead, actions and outcomes can be selected that represent common mistakes or that teach lessons (both good and bad) that are critical to the success of platoon operations. Showing each crew its mistakes and successes in the AAR is impractical and may not be the most effective or efficient training technique.

Facilities and Equipment

Currently, the AAR is conducted in a 12 x 25 foot trailer. Eugene Drucker and his associates at the Human Resources Research Organization and the Army Research Institute observed that the AAR facility being used at Fort Hood was inadequate for conducting the AAR. PM-TRADE has recommended increasing the size of the facility to 25 x 25 feet, but this may still be inadequate, given plans to add the CGI map display and another computer.

Kraemer and Koger (1989) noted that positioning video monitors on individual tables was not conducive to viewing the run from a platoon perspective. They also discussed the problem of synchronizing playback of the tapes so that the crews could view their tapes simultaneously. Kraemer and Koger suggest arranging the monitors in an array at the front of the AAR facility, so that the crews can view the scenario actions and outcomes from a platoon perspective. Add the capability to control the playback of the four video machines from a single remote device and the synchronization problem is solved. However, the ability of the crews to attend to action taking place simultaneously on four different monitors has not been evaluated and may not be training effective. Attending visually to the four monitors and simultaneously listening to the four audio tracks may prove impossible. If this solution is adopted, the audio should be turned off except for that recorded from the platoon leader's vehicle.

A preferred solution is to be able to access each video tape quickly and selectively from a single remote control device held by the AAR presenter. Integration of feedback sources (i.e., TSV, CGI map, TPV, CPO) would permit rapidly switching from one data source to the next with all crews viewing the same information at any given time. The crews could then view the presentation on their own individual monitors or view a single large monitor located in the front of the room. An advantage of this configuration is that the AAR presenter and the crews can focus their attention on the same information. Attending to the same information during the AAR should facilitate discussion and encourage crew participation. In this configuration, the TSV tapes would not be the primary source of information for the AAR; rather they would be used to diagnose the causes of deficiencies identified through other feedback sources. The CGI map graphics display and the computer formats would be the primary data sources.

Personnel

Ideally the units could conduct their own AAR's without any outside assistance or interference. However, the complexity of the PRIME feedback system and the inexperience of units in using such systems in training means that the unit will need and indeed desire help in conducting their AAR's. An AAR expert should be present at all times to assist or guide the unit leaders in conducting their AAR's. This expert must be intimately familiar with the PRIME scenarios, equipment, performance evaluation methods, and AAR formats for each feedback source. The expert also must be aware of unit training objectives and immediate training goals. With sufficient experience in using PRIME, unit personnel (e.g., the battalion master gunner) may be able to serve as the AAR expert. However, dedicated range personnel might better be able to serve as the AAR expert.

Information Overload

The data gathering capabilities of modern training devices such as PRIME are beginning to exceed the capabilities to organize, reduce and summarize the data for training and performance evaluation purposes. Training developers responsible for device procurement and design must not only decide what measures are needed for training, but also determine how to best organize and summarize the measures for presentation of effective training. Ideally, the data should be collected in a format that is compatible with effective and efficient training. If data are not collected in such a format, provision should be made to reduce the data or transform them so that they can be used to train effectively. Training devices should include features that

facilitate data extraction, reduction and transformation for presentation during training. Otherwise, the soldiers may become needlessly confused when confronted by reams of data that are not presented in an organized fashion.

REFERENCES

Downs, C. W., Johnson, K. M., and Fallesen, J. J. (1987). Analysis of feedback in after action reviews (ARI Technical Report 745). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A188 336)

Elias, L. W. (1988, November). Mirimar does battle high and low. National Defense, Vol. LXXIII, No. 442, pp. 21-24.

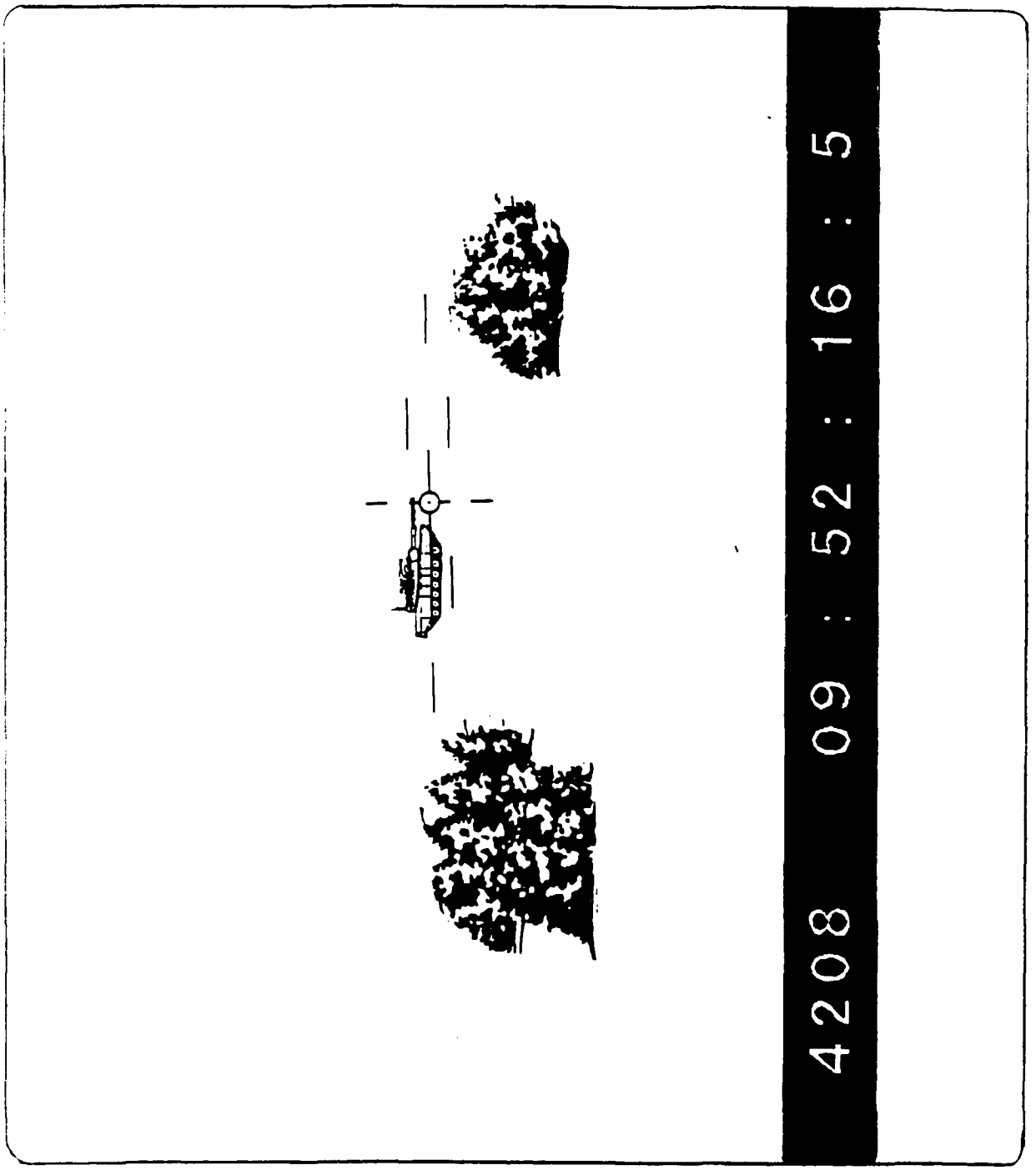
Kraemer, R. E., and Koger, M. E. (1989). Tank platoon training using the Precision Range Integrated Maneuver Exercise (PRIME) system as perceived by company team commanders (ARI Research Report 1542). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A217 449)

Scott, T. D. (1983). Tactical engagement after action review guidebook (ARI Research Product 83-13). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A143 014)

U.S. Army, III Corps, G-3 Training. (1988). Phantom Run Instrumented MILES Enhanced (PRIME) system capabilities overview. Fort Hood, TX: Author.

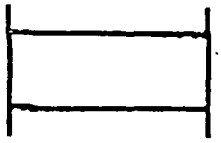
APPENDIX A

PICTORIAL REPRESENTATION OF TSV FORMAT



APPENDIX B

PROPOSED MAP GRAPHICS DISPLAY FEATURES AND SYMBOLOGY



TANK

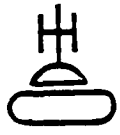
USED FOR M1, M60, T80,

WHEELED ARMORED
PERSONNEL CARRIER

USED FOR BTR-60, BRDM, BRDM-2, BTR-70

BRADLEY INFANTRY
FIGHTING VEHICLE

USED FOR M2 & M3 BRADLEY FIGHTING VEHICLE, BMP, BMP-2

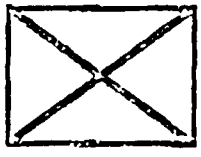


AIR DEFENSE GUN
SELF-PROPELLED

USED FOR ZSU 23/4

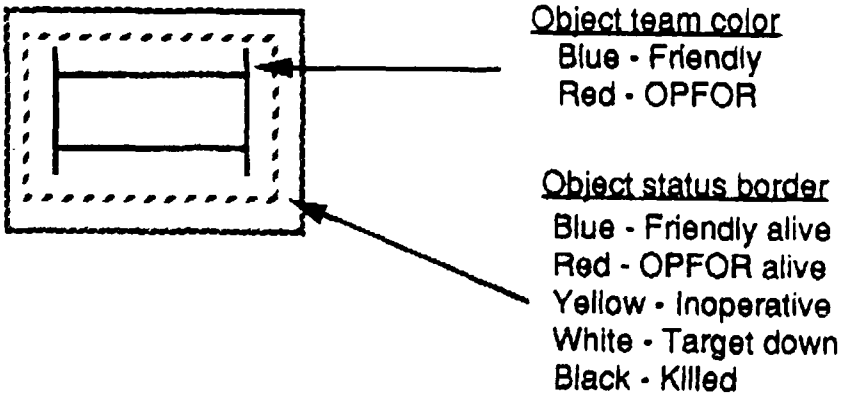
ANTI-TANK
ROCKET

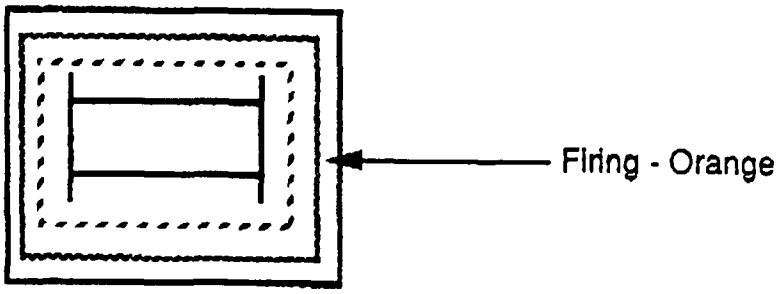
USED FOR RPG TEAM

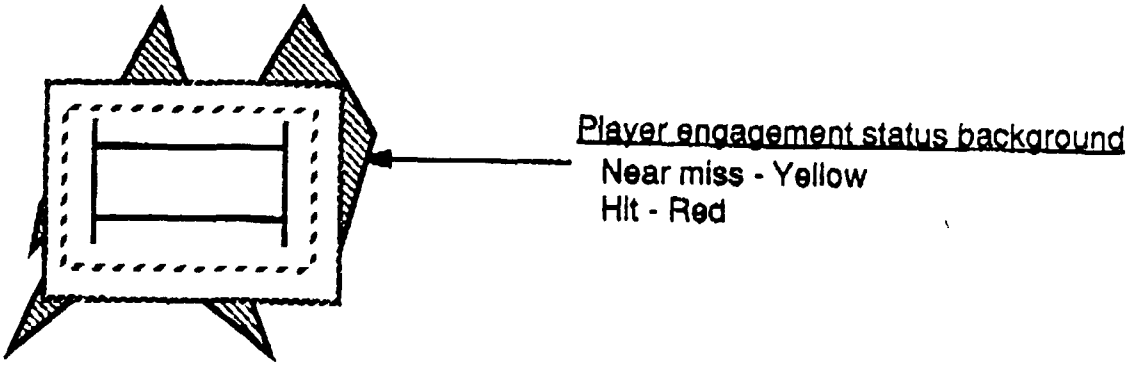


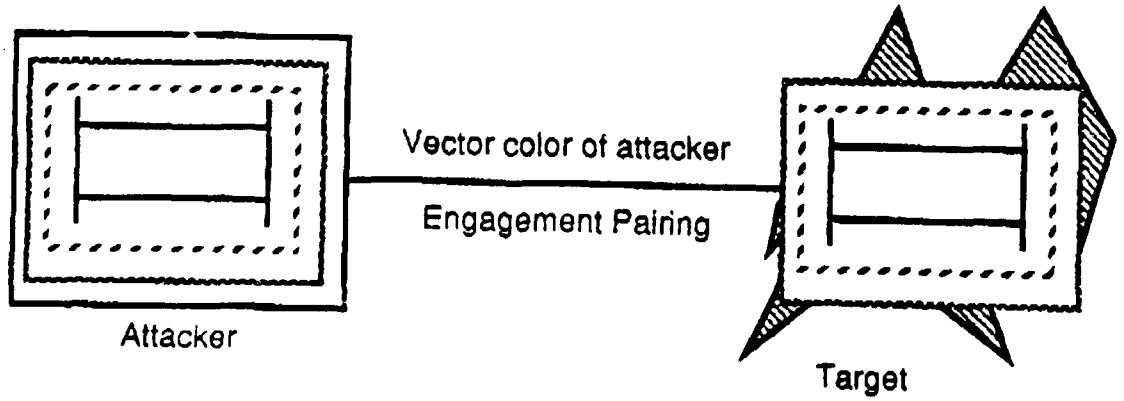
INFANTRY UNIT

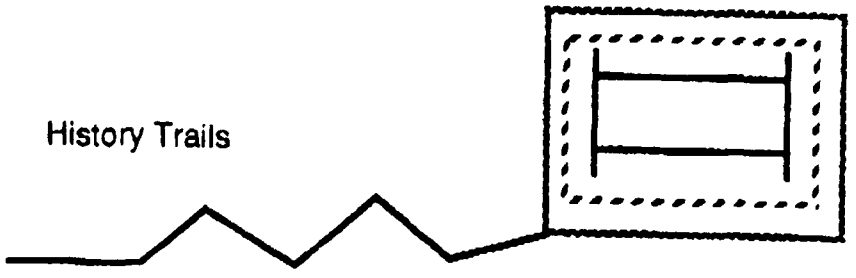
USED FOR INFANTRY SQUAD


Object team color
Blue - Friendly
Red - OPFOR
Object status border
Blue - Friendly alive
Red - OPFOR alive
Yellow - Inoperative
White - Target down
Black - Killed


Firing - Orange


Player engagement status background
Near miss - Yellow
Hit - Red


Vector color of attacker
Engagement Pairing
Attacker
Target


History Trails

Record#	D	HH	MM	SS	T	V	BUMPER	DTN	STATUS	KILL	HIT	MEM DUMP	EVENT	M CODE	PLAYFIELD
1	3	12	49	47	1	WHITE	6	PK27334510	Alive	No		No	Weapon Fired	Main Gun	--- ----
2	3	12	49	50	9	WHITE	6	PK27334509	Alive	No		No	Near Miss	Main Gun	TGT 5
3	3	12	49	48	7	GOLD	4	PK27324503	Alive	No		No	Weapon Fired	Main Gun	--- ---
4	3	12	49	52	5	GOLD	4	PK27324503	Alive	No		No	Auto Weap Trig Rel	--- ---	--- ---
5	3	12	49	55	3	GOLD	4	PK27314502	Alive	No		No	Weapon Fired	Main Gun	--- ---
6	3	12	49	59	4	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	TGT 6
7	3	12	50	03	4	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	TGT 6
8	3	12	50	03	9	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	TGT 6
9	3	12	49	57	7	WHITE	6	PK27334509	Alive	No		No	Weapon Fired	Main Gun	--- ---
10	3	12	50	06	3	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	TGT 6
11	3	12	50	06	8	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	TGT 6
12	3	12	50	07	1	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	TGT 6
13	3	12	50	05	3	WHITE	6	PK27274511	Alive	No		No	Weapon Fired	Main Gun	--- ---
14	3	12	49	58	8	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	phantom
15	3	12	50	02	8	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	phantom
16	3	12	50	03	3	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	phantom
17	3	12	50	05	8	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	phantom
18	3	12	50	06	3	GOLD	4	PK27314502	Alive	No		No	Near Miss	Main Gun	phantom
19	3	12	50	08	3	GOLD	4	PK27304503	Alive	No		No	Auto Weap Trig Rel	--- ---	--- ---
20	3	12	50	11	0	GOLD	4	PK27304503	Alive	No		No	Near Miss	Main Gun	TGT 6
21	3	12	50	11	2	GOLD	4	PK27304503	Alive	No		No	Near Miss	Main Gun	TGT 6
22	3	12	50	10	4	GOLD	4	PK27304503	Alive	No		No	Near Miss	Main Gun	phantom
23	3	12	50	10	6	GOLD	4	PK27304503	Alive	No		No	Near Miss	Main Gun	phantom
24	3	12	50	12	1	GOLD	6	PK27394523	Alive	No		No	Near Miss	Main Gun	TGT 1
25	3	12	50	10	9	GOLD	6	PK27394523	Alive	No		No	Near Miss	Main Gun	phantom
26	3	12	50	16	4	GOLD	4	PK27304503	Alive	No		No	Near Miss	Main Gun	TGT 6
27	3	12	50	23	9	GOLD	6	PK27384523	Alive	No		No	Weapon Fired	Main Gun	--- ---
28	3	12	50	30	6	GOLD	6	PK27364525	Alive	No		No	Near Miss	Main Gun	TGT 6
29	3	12	50	30	8	GOLD	6	PK27364525	Alive	No		No	Near Miss	Main Gun	TGT 6
30	3	12	50	31	1	WHITE	3	PK27194508	Dead	No		No	Kill	Main Gun	TGT 6
31	3	12	50	34	3	WHITE	6	PK27164513	Dead	No		No	Kill	Main Gun	TGT 1
32	3	12	50	34	5	GOLD	4	PK27194505	Dead	No		No	Kill	Main Gun	TGT 1
33	3	12	50	23	9	GOLD	6	PK27364525	Alive	No		No	Weapon Fired	Main Gun	--- ---
34	3	12	50	29	4	GOLD	6	PK27364525	Alive	No		No	Near Miss	Main Gun	phantom
35	3	12	50	29	7	GOLD	6	PK27364525	Alive	No		No	Near Miss	Main Gun	phantom
36	3	12	50	31	0	GOLD	6	PK27364525	Alive	No		No	Auto Weap Trig Rel	--- ---	--- ---
37	3	12	50	23	9	GOLD	6	PK27154523	Alive	No		No	Weapon Fired	Main Gun	--- ---
38	3	12	50	29	4	GOLD	6	PK27154523	Alive	No		No	Near Miss	Main Gun	phantom
39	3	12	50	29	7	GOLD	6	PK27154523	Alive	No		No	Near Miss	Main Gun	phantom
40	3	12	50	31	0	GOLD	6	PK27154523	Alive	No		No	Auto Weap Trig Rel	--- ---	--- ---
41	3	12	50	23	9	GOLD	6	PK27154523	Alive	No		No	Weapon Fired	Main Gun	--- ---
42	3	12	50	29	4	GOLD	6	PK27154523	Alive	No		No	Near Miss	Main Gun	phantom
43	3	12	50	29	7	GOLD	6	PK27154523	Alive	No		No	Near Miss	Main Gun	phantom
44	3	12	50	31	0	GOLD	6	PK27154523	Alive	No		No	Auto Weap Trig Rel	--- ---	--- ---
45	3	12	51	07	7	GOLD	6	PK27134523	Alive	No		No	Near Miss	Main Gun	TGT 6
46	3	12	51	11	0	GOLD	6	PK27134523	Dead	No		No	Kill	Main Gun	TGT 5
47	3	12	51	11	8	GOLD	4	PK27194505	Alive	No		No	Resurrect	--- ---	--- ---
48	3	12	51	24	5	GOLD	6	PK27134523	Alive	No		No	Resurrect	--- ---	--- ---
49	3	12	51	38	7	WHITE	6	PK27164513	Alive	No		No	Resurrect	--- ---	--- ---
50	3	12	52	28	1	GOLD	6	PK27014525	Dead	No		No	Kill	Main Gun	TGT 15 1
51	3	12	53	32	6	WHITE	3	PK27194508	Alive	No		No	Resurrect	--- ---	--- ---
52	3	12	53	32	8	WHITE	3	PK27194508	Alive	No		No	Resurrect	--- ---	--- ---

43	3	12	50	37	0	TGT	1	PK27194540	Up	No	No	Target Fire	Main Gun
44	3	12	50	36	8	TGT	1	PK27194540	Down	No	No	Target Fire	Main Gun
45	3	12	50	27	0	TGT	6	PK27054538	Down	No	No	Hit	Main Gun GOLD 6
46	3	12	51	10	8	TGT	6	PK27054538	Up	No	No	Target Fire	Main Gun
47	3	12	51	11	1	TGT	3	PK27124520	Up	No	No	Target Fire	Main Gun
48	3	12	51	10	2	TGT	3	PK27124520	Down	No	No	Target Fire	Main Gun
49	3	12	51	26	4	TGT	13	I PK26604548	Up	No	No	Target Up	
50	3	12	51	26	8	TGT	13	I PK26604548	Up	No	No	Target Fire	Main Gun
51	3	12	52	26	8	TGT	13	I PK26604548	Up	No	No	Target Fire	Main Gun
52	3	12	52	36	8	TGT	13	I PK26604548	Up	No	No	Target Down	
53	3	12	54	23	6	TGT	14	PK26344544	Up	No	No	Target Up	
54	3	12	54	23	9	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
55	3	12	54	23	7	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
56	3	12	54	36	7	TGT	14	PK26344544	Up	No	No	Hit	Main Gun WHITE 6
57	3	12	54	37	8	TGT	14	PK26344544	Up	No	No	Near Miss	Main Gun phantom
58	3	12	54	40	3	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
59	3	12	54	40	5	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
60	3	12	54	40	3	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
61	3	12	54	59	1	TGT	14	PK26344544	Up	No	No	Hit	Main Gun phantom
62	3	12	55	00	3	TGT	14	PK26344544	Up	No	No	Near Miss	Main Gun phantom
63	3	12	55	00	3	TGT	14	PK26344544	Up	No	No	Hit	Main Gun GOLD 6
64	3	12	55	01	4	TGT	14	PK26344544	Up	No	No	Near Miss	Main Gun GOLD 6
65	3	12	55	01	6	TGT	14	PK26344544	Up	No	No	Hit	Main Gun GOLD 6
66	3	12	55	02	0	TGT	14	PK26344544	Up	No	No	Hit	Main Gun WHITE 6
67	3	12	55	02	5	TGT	14	PK26344544	Up	No	No	Hit	Main Gun phantom
68	3	12	55	05	0	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
69	3	12	55	06	4	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
70	3	12	55	06	6	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
71	3	12	55	07	9	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
72	3	12	55	08	1	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
73	3	12	55	08	2	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
74	3	12	55	09	6	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
75	3	12	55	29	9	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
76	3	12	55	30	0	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
77	3	12	55	43	9	TGT	14	PK26344544	Up	No	No	Target Fire	Main Gun
78	3	12	55	48	0	TGT	7	PK26254550	Up	No	No	Target Up	
79	3	12	55	48	5	TGT	7	PK26254550	Up	No	No	Target Fire	Main Gun
80	3	12	55	48	8	TGT	8	PK26294553	Up	No	No	Target Up	
81	3	12	55	49	0	TGT	8	PK26294553	Up	No	No	Target Fire	Main Gun
82	3	12	55	49	1	TGT	9	PK26334560	Up	No	No	Target Up	
83	3	12	55	49	3	TGT	9	PK26334560	Up	No	No	Target Fire	Main Gun
84	3	12	55	49	4	TGT	10	PK26334563	Up	No	No	Target Up	
85	3	12	55	49	7	TGT	10	PK26334563	Up	No	No	Target Fire	Main Gun
86	3	12	55	49	8	TGT	16	PK26244532	Up	No	No	Target Up	
87	3	12	55	50	0	TGT	16	PK26244532	Up	No	No	Target Fire	Main Gun
88	3	12	55	50	2	TGT	17	I PK26274522	Up	No	No	Target Up	
89	3	12	55	50	5	TGT	17	I PK26274522	Up	No	No	Target Fire	Main Gun
90	3	12	55	50	6	TGT	50	PK26424554	Up	No	No	Target Up	
91	3	12	55	50	8	TGT	50	PK26424554	Up	No	No	Target Fire	Main Gun
92	3	12	48	16	7	TGT	7	PK26254550	Up	No	No	Init By RCC	
93	3	12	49	13	8	TGT	7	PK26254550	Up	No	No	Target Down	
94	3	12	55	47	2	TGT	7	PK26254550	Up	No	No	Target Up	
95	3	12	48	19	7	TGT	9	PK26334560	Up	No	No	Init By RCC	
96	3	12	49	14	6	TGT	9	PK26334560	Up	No	No	Target Down	
97	3	12	55	48	3	TGT	9	PK26334560	Up	No	No	Target Up	
98	3	12	48	21	1	TGT	10	PK26334563	Up	No	No	Init By RCC	
99	3	12	49	15	7	TGT	10	PK26334563	Up	No	No	Target Down	
100	3	12	55	49	2	TGT	10	PK26334563	Up	No	No	Target Up	
101	3	12	48	42	0	TGT	16	PK26244532	Up	No	No	Init By IN	
102	3	12	49	17	0	TGT	15	PK26244532	Up	No	No	Target Down	
103	3	12	55	49	7	TGT	16	PK26244532	Up	No	No	Target Up	

APPENDIX D

ENGAGEMENT SUMMARY FORMAT (FORT HOOD VERSION)